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PROVISIONAL SPECIFICATION

LIQUID ALTERNATIVE TO BULK GYPSUM IN AGRICULTURAL AND HORTICULTURAL APPLICATIONS

The invention is described in the following statement:

LIQUID ALTERNATIVE TO BULK GYPSUM IN AGRICULTURAL AND HORTICULTURAL APPLICATIONS

Many Australian soils have a poor structure. This is indicated by poor water penetration; surface crusting when dry; restricted root growth and poor germination.

Excess sodium content in the soil is a primary cause of bad structure. When a soil high in sodium is wet, very fine clay particles disperse into the soil water. They move with this water and then settle out in the fine pores between the soil particles. When the pores are blocked, the soil becomes dense, restricting the movement of water, air, plant roots and tillage equipment and significantly reducing the productivity of whatever crop or pasture is growing on that area.

Gypsum (calcium sulphate) has traditionally been used as a means of improving the friability of clay soils by reducing sodium levels. The calcium ions in the gypsum displace the sodium ions off the outside of the clay particles. The sodium can then be washed down through the soil. The calcium helps clay particles to link up into an organised lattice of particles, resulting in a more "open" soil structure.

$$\begin{matrix} Na \\ Na \end{matrix} \boxed{\text{clay micelle}} + CaSO_4 \rightleftharpoons Ca \boxed{\text{clay micelle}} + Na_2SO_4 \text{ (leachable)}$$

However, bulk gypsum must be applied at very high rates – commonly about 5 tonnes per hectare in heavy clay soils - and it can be difficult and expensive to ~~spend~~. Spread .

Furthermore, it is not feasible to apply bulk gypsum in many situations, as the spreading equipment is too large. In many vineyards, for example, the rows of vines are too close together to allow a large vehicle to have access.

A further problem with bulk gypsum is that it may take 12 months or more to become effective because the particle sizes are relatively large. The effectiveness of the gypsum in dispersing the sodium ions in the clay is directly related to the surface area exposed to the clay, and finer particles have a greater surface area than large particles for the same given weight.

Gypsum particles are commonly of the order of 1mm diameter (1000 micron) or more. Although, finer particles could be produced by milling, the gypsum "dust" produced by this process would be extremely difficult to spread.

Other products which could also be used to displace sodium ions are available as alternatives to gypsum, but they have major disadvantages:

Sulphur powder:

Sulphur undergoes oxidation in soil to form sulphuric acid which in turn reacts with any lime present in the soil to form calcium sulphate (gypsum). However, sulphur powder is very fine, and would be difficult to spread.

$$2\,S + 3\,O_2 \longrightarrow 2\,SO_3 \quad \text{(microbiological oxidation)}$$

$$SO_3 + H_2O = H_2SO_4$$

$$H_2SO_4 + CaCO_3 \rightleftharpoons CaSO_4 + H_2O + CO_2$$

$$\begin{matrix} Na \\ Na \end{matrix}\boxed{\text{clay micelle}} + CaSO_4 \rightleftharpoons Ca\,\boxed{\text{clay micelle}} + Na_2SO_{4\,(\text{leachable})}$$

Sulphuric acid:

Sulphuric acid is chemically hydrogen sulphate. Upon application to soils containing calcium carbonate, it immediately reacts to form calcium sulphate. However, being an acid, it is difficult to work with, requiring special equipment.

$$CaCO_3 + H_2SO_4 \rightleftharpoons CaSO_4 + H_2O + CO_2$$

$$\begin{matrix} Na \\ Na \end{matrix}\boxed{\text{clay micelle}} + CaSO_4 \rightleftharpoons Ca\,\boxed{\text{clay micelle}} + Na_2SO_{4\,(\text{leachable})}$$

<u>Calcium chloride</u>:

The calcium ions displace the sodium ions in the clay – in the same way as gypsum does. However, the residual product in this reaction is sodium chloride (common salt). Salinity is already a major problem and, for most users, the application of calcium chloride is not a viable option to address a clay problem.

$$\begin{matrix}\mathrm{Na}\\ \mathrm{Na}\end{matrix}\boxed{\text{clay micelle}} + \mathrm{CaCl_2} \rightleftharpoons \mathrm{Ca}\,\boxed{\text{clay micelle}} + \underset{\text{(leachable)}}{2\ \mathrm{NaCl}}$$

The problems associated with the use of the above products to improve clay soils are overcome by the present invention.

In the preferred form of this invention, a suspension agent such as PVA is mixed into water, and about 900 grams of superfine calcium carbonate (rock lime) per litre of water is blended in. About 250 grams of sulphur powder, combined with a wetting agent to assist its dispersion, is also blended into the liquid. These quantities result in a liquid with a calcium content of about 35% and a sulphur content of about 25%. In contrast, gypsum has a calcium content of about 22% and a sulphur content of about 17%.

When the product is applied to the soil, the sulphur reacts with the oxygen in the soil, in the same way as sulphur powder described above.

Furthermore, whereas sulphur powder requires lime to be present in the soil for the sodium to be successfully ~~be~~ removed, in this invention the lime (superfine calcium carbonate) is provided in the applied liquid.

A key inventive step in this invention, therefore, is the provision of a liquid which contains both components required for the effective removal of sodium from the soil. Furthermore, the components do not begin to react until they are exposed to oxygen in the soil.

The key advantages of this invention are as follows:

1. Being in a liquid form, the product can be applied through irrigation, fertigation, boom spray or any other system where water is applied to plants or soil. This means that a wide variety of commercial growers and other potential users who could not previously use gypsum now have a means of breaking down their clay soils.

2. Because the particles are superfine (maximum 25 micron; average 5 micron in the preferred form of this invention), the product can safely be applied through fine filter systems. Filters are normally 45 micron or coarser. There is no need for the particles to be dissolved in water to enable them to pass through into the soil.

3. The very small particle size in the preferred form of this invention results in a much more rapid response than traditional gypsum.

   The Exchangeable Sodium Percentage (ESP) is a common measure of the sodium level in a soil. A soil with a high ESP will generally have poor water penetration, will develop surface crusting, and will be difficult for most root growth.

   Tests have shown that the ESP was reduced substantially in only 4 weeks with a single application of the liquid suspension of calcium carbonate and sulphur as described in this Provisional Specification.

4. Tests have shown that there was no appreciable change in the pH (acidity/alkalinity) of the soil 4 weeks after the application of this invention. Although calcium carbonate is an alkaline product, and therefore might be expected to increase the alkalinity of the soil to which it is applied, this effect is offset by the conversion of the sulphur in the product to sulphuric acid as described above. This is an important factor for commercial growers, where changes in pH can have a substantial impact on crop productivity.

In a variation of this invention, sulphur powder could be suspended in a liquid without the addition of calcium carbonate. Such a product would be effective as a means of breaking down clay soils in those instances where the soil already contains sufficiently high calcium levels.

Although the above discussion has related to the commercial use of the invention; its application is not confined to this market: home gardeners will also benefit from its advantages.